

Vegetation Structure from the Quantitative Fusion of Radar Interferometric and Hyperspectral Optical Remote Sensing

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Radar interferometry and hyperspectral optical remote sensing data are sensitive to vegetation structure[1,2]. Quantitative measurements of vegetation structure result from combining microwave and optical observations through physical-model-based parameter estimation. This approach to quantitative fusion potentially leads to the most reliable vegetation parameter estimates since the range of physically-plausible solutions is greatly narrowed. Multialtitude interferometric AIRSAR data and AVIRIS hyperspectral reflectance data collected over well-calibrated sites in Central Oregon comprise the observation vector from which leaf area density (LAD = the amount and distribution of leaf area in 3-D space) can be estimated. Two methods of parameter estimation from these data are explored in this paper: 1) estimating parameters from each data set separately and combining those parameters to form leaf area density, and 2) combining the data in a single parameter-estimation process via a physical model that describes both the microwave and optical data, and from which LAD emerges as a parameter. Leaf area densities derived from each approach are compared to field measurements.

In the first method, a two-layer vegetation model describes the microwave data, and enables the estimation of parameters describing each layer. The thickness of each vegetation layer is estimated along with the ratio of the vegetation densities in the layers. A hyperspectral canopy radiative transfer model simulates the optical data, which leads to the estimation of the total canopy leaf area index (LAI) [3]. The microwave-derived density ratio parameter is combined with the total LAI parameter to produce LAD.

In the second method, a single physical model expresses the microwave interferometric amplitudes and phases and the hyperspectral reflectance factors in terms of vegetation structural parameters, including the two-level LAD. This second approach has the potential to be the most efficient and accurate use of the combined data set, but also requires more extensive integration of models.

[1] R. N. Treuhaft and P. R. Siqueira, "The vertical structure of vegetated land surfaces from interferometric and polarimetric radar," *Radio Science*, January 2000.

[2] J. K. Ross, *The Radiation Regime and Architecture of Plant Stands*, Kluwer Academic, Boston, MA, 1981.

[3] Asner, G.P. "A hybrid radiative transfer/geometric-optical model for simulating hyperspectral signatures of ecosystems," *Proc. of 9th AVIRIS Workshop*, NASA Jet Propulsion Laboratory, 1999. In press.

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